Lecture 2

Understanding Users

User Characteristics

Unit 3:

Cognitive Aspects & Human Abilities

Objectives

- The main aims of this chapter are to:

  - Explain what cognition is and why it is important for interaction design.
  - Discuss what attention is and its effects on our ability to multitask.
  - Describe how memory can be enhanced through technology aids.
  - Explain what mental models are.
  - Show the difference between classic internal cognitive frameworks (e.g. mental models) and more recent external cognitive approaches (e.g. distributed cognition) that have been applied to HCI.

Why do we need to understand users?

- Interacting with technology is cognitive
- Need to take into account cognitive processes involved and cognitive limitations of users
- Provides knowledge about what users can and cannot be expected to do
- Identifies and explains the nature and causes of problems users encounter
- Supply theories, modelling tools, guidance and methods that can lead to the design of better interactive products

Cognitive processes

- Attention
- Perception and recognition
- Memory
- Learning & Mental Models

Attention

- Selecting things to concentrate on at a point in time from the mass of stimuli around us
- Allows us to focus on information that is relevant to what we are doing
- Involves audio and/or visual senses
- Information at the interface should be structured to capture users' attention, e.g. use perceptual boundaries (windows), colour, reverse video, sound and flashing lights

Activity: Find the price of a double room at the Holiday Inn in Bradley

Pennsylvania
Bedford Motel/Hotel: Crinaline Courts
(814) 623-9511 S: $18 D: $20
Bedford Motel/Hotel: Holiday Inn
(814) 623-9006 S: $29 D: $36
Bedford Motel/Hotel: Midway
(814) 623-8107 S: $21 D: $26
Bedford Motel/Hotel: Penn Manor
(814) 623-8177 S: $19 D: $25
Bedford Motel/Hotel: Quality Inn
(814) 623-5189 S: $23 D: $28
Bedford Motel/Hotel: Terrace
(814) 623-5111 S: $22 D: $24
Bradley Motel/Hotel: De Soto
(814) 362-3567 S: $20 D: $24
Bradley Motel/Hotel: Holiday House
(814) 362-4511 S: $22 D: $25
Bradley Motel/Hotel: Holiday Inn
(814) 362-4501 S: $32 D: $40
Breezewood Motel/Hotel: Best Western Plaza
(814) 735-4352 S: $20 D: $27
Breezewood Motel/Hotel: Motel 70
(814) 735-4385 S: $16 D: $18

Activity: Find the price for a double room at the Quality Inn in Columbia

South Carolina

City	Motel/Hotel	Area code	Phone	Rates Single	Rates Double
Charleston	Best Western	803	747-0961	$26	$30
Charleston	Days Inn	803	881-1000	$18	$24
Charleston	Holiday Inn N	803	744-1621	$36	$46
Charleston	Holiday Inn SW	803	556-7100	$33	$47
Charleston	Howard Johnsons	803	524-4148	$31	$36
Charleston	Ramada Inn	803	774-8281	$33	$40
Charleston	Sheraton Inn	803	744-2401	$34	$42
Columbia	Best Western	803	796-9400	$29	$34
Columbia	Carolina Inn	803	799-8200	$42	$48
Columbia	Days Inn	803	736-0000	$23	$27
Columbia	Holiday Inn NW	803	794-9440	$32	$39
Columbia	Howard Johnsons	803	772-7200	$25	$27
Columbia	Quality Inn	803	772-0270	$34	$41
Columbia	Ramada Inn	803	796-2700	$36	$44
Columbia	Vagabond Inn	803	796-6240	$27	$30

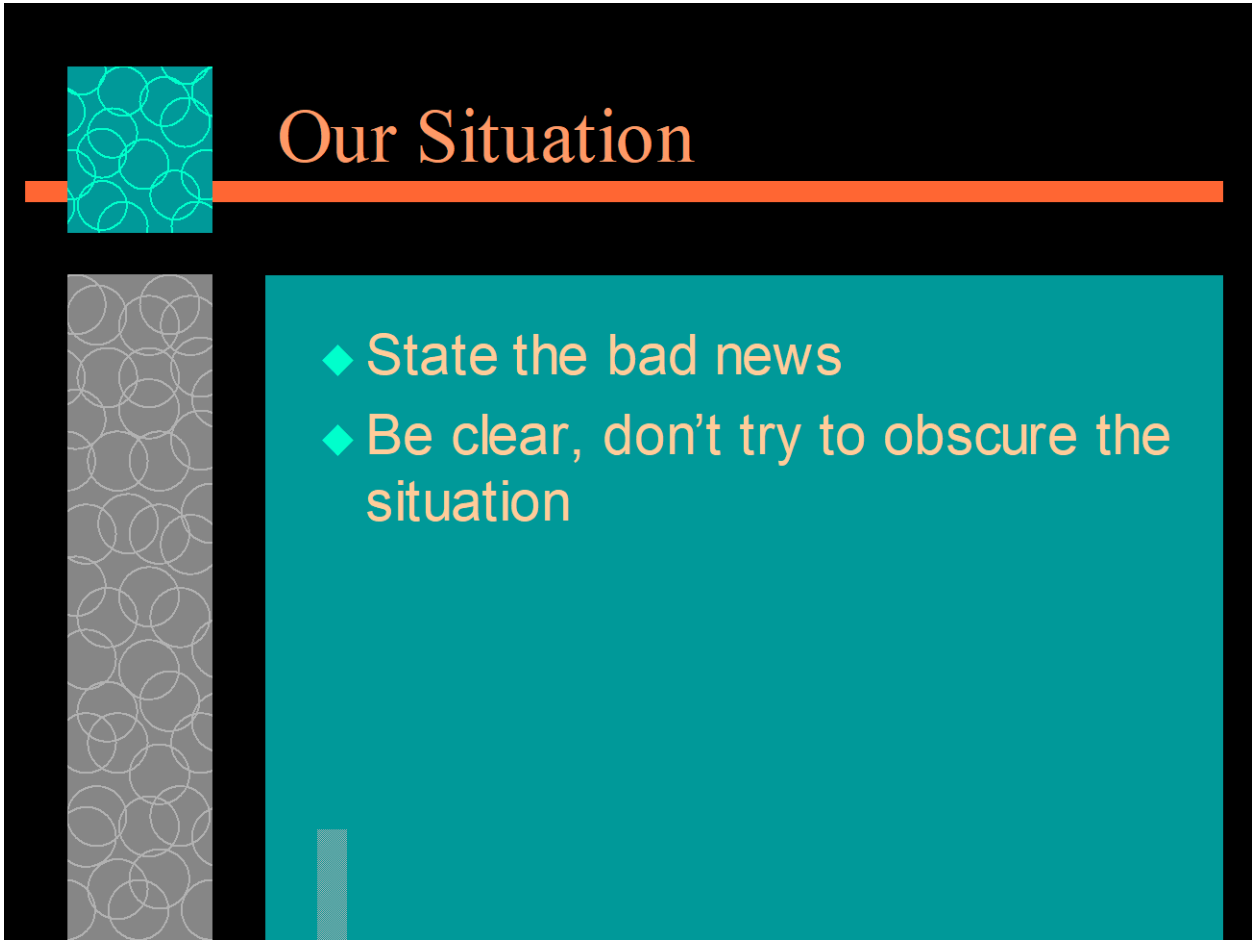
Activity

- Tullis (1987) found that the two screens produced quite different results
  - 1st screen - took an average of 5.5 seconds to search
  - 2nd screen - took 3.2 seconds to search
- Why, since both displays have the same density of information (31%)?
- Spacing
  - In the 1st screen the information is bunched up together, making it hard to search
  - In the 2nd screen the characters are grouped into vertical categories of information making it easier

Design implications for attention

- Make information salient when it needs attending to
- Use techniques that make things stand out like color, ordering, spacing, underlining, sequencing and animation
- Avoid cluttering the interface with too much information even if the software allows it

An example of over-use of graphics



Perception

- How information is acquired from the world and transformed into experiences
- Obvious implication is to design representations that are readily perceivable, e.g.
  - Text should be legible
  - Icons should be easy to distinguish and read

Is color contrast good? Find italian

Black Hills Forest	Peters Landing	Jefferson Farms	Devlin Hall
Cheyenne River	Public Health	Psychophysics	Positions
Social Science	San Bernardino	Political Science	Hubard Hall
South San Jose	Moreno Valley	Game Schedule	Fernadino Beach
Badlands Park	Altamonte Springs	South Addision	Council Bluffs
Juvenile Justice	Peach Tree City	Cherry Hills Village	Classical Lit
Results and Stats	Highland Park	Creative Writing	Sociology
Thousand Oaks	Manchesney Park	Lake Havasu City	Greek
Promotions	Vallecito Mts.	Engineering Bldg	Wallace Hall
North Palermo	Rock Falls	Sports Studies	Concert Tickets
Credit Union	Freeport	Lakewood Village	Public Radio FM
Wilner Hall	Slaughter Beach	Rock Island	Children's Museum
Performing Arts	Rocky Mountains	Deerfield Beach	Writing Center
Italian	Latin	Arlington Hill	Theater Auditions
Coaches	Pleasant Hills	Preview Game	Delaware City
McKees Rocks	Observatory	Richland Hills	Scholarships
Glenwood Springs	Public Affairs	Experts Guide	Hendricksville
Urban Affairs	Heskett Center	Neff Hall	Knights Landing
McLeansboro	Brunswick	Grand Wash Cliffs	Modern Literature
Experimental Links	East Millinocket	Indian Well Valley	Studio Arts
Graduation	Women's Studies	Online Courses	Hughes Complex
Emory Lindquist	Vacant	Lindquist Hall	Cumberland Flats
Clinton Hall	News Theatre	Fisk Hall	Central Village
San Luis Obispo	Candlewood Isle	Los Padres Forest	Hoffman Estates

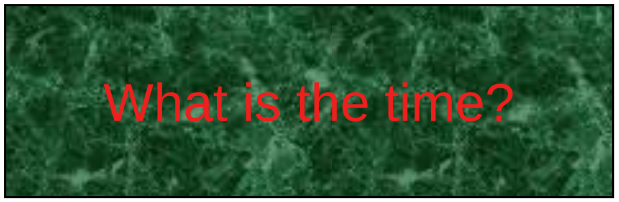
Are borders and white space better? Find french

Webmaster	Curriculum	Student Life	Dance
Russian	Emergency (EMS)	Accountancy	Gerontology
Athletics	Statistics	McKnight Center	Marketing
Go Shockers	Award Documents	Council of Women	College Bylaws
Degree Options	Language Center	Commute	Why Wichita?
Newsletter	Future Shockers	Small Business	Tickets
Geology	Intercollegiate	Thinker & Movers	Career Services
Manufacturing	Bowling	Alumni	Doers & Shockers
Management	Wichita Gateway	Foundations	Core Values
UCATS	Transfer Day	Corbin Center	Grace Wilkie Hall
Alumni News	Job Openings	Jardine Hall	Strategic Plan
Saso	Live Radio	Hugo Wall School	Medical Tech
Educational Map	Beta Alpha Psi	Staff	Softball, Men's
Physical Plant	Liberal Arts	Aerospace	McKinley Hall
Graphic Design	Counseling	Choral Dept.	Email
Non Credit Class	Biological Science	Alberg Hall	Dental Hygiene
Media Relations	Duerksen Fine Art	French	Tenure
Advertising	EMT Program	Spanish	Personnel Policies
English	Religion	Parents	Instrumental
Graduate Complex	Art Composition	Wrestling	Nursing
Music Education	Physics	Philosophy	Opera
Advising Center	Entrepreneurship	Wichita Lyceum	Sports History
Medical School	Koch Arena	Fairmount Center	Athletic Dept.
Levitt Arena	Roster	Women's Museum	Health Plan

Activity

- Weller (2004) found people took less time to locate items for information that was grouped
  - using a border (2nd screen) compared with using color contrast (1st screen)
- Some argue that too much white space on web pages is detrimental to search
  - Makes it hard to find information
- Do you agree?

Which is easiest to read and why?



What is the time?

What is the time?

What is the time?

What is the time?

Design implications

- **Icons** should enable users to readily *distinguish* their meaning
- **Bordering and spacing** are effective visual ways of grouping information
- **Sounds** should be audible and distinguishable
- **Speech** output should enable users to distinguish between the set of spoken words
- **Text** should be legible and distinguishable from the background
- **Feedback** should allow users to recognize and distinguish different meanings

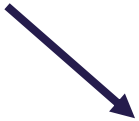
Memory

There are three types of memory function:

Sensory memories

Attention

Short-term memory or working memory



Rehearsal

Long-term memory

Selection of stimuli governed by level of arousal.

sensory memory

- Buffers for stimuli received through senses
  - iconic memory: visual stimuli
  - echoic memory: aural stimuli
  - haptic memory: tactile stimuli
- Examples
  - “sparkler” trail
  - stereo sound
- Continuously overwritten

Short-term memory (STM)

- Scratch-pad for temporary recall
  - rapid access ~ 70ms
  - rapid decay ~ 200ms
  - limited capacity - 7± 2 chunks

Examples

212348278493202

0121 414 2626

HEC ATR ANU PTH ETR EET

The problem with the classic '7±2'

- George Miller's (1956) theory of how much information people can remember
- People's immediate memory capacity is very limited
- Many designers think this is useful finding for interaction design
- But…

What some designers get up to…

- Present only 7 options on a menu
- Display only 7 icons on a tool bar
- Have no more than 7 bullets in a list
- Place only 7 items on a pull down menu
- Place only 7 tabs on the top of a website page
  - But this is wrong? Why?

Why?

- Inappropriate application of the theory
- People can **scan** lists of bullets, tabs, menu items for the one they want
- They don’t have to **recall** them from memory having only briefly heard or seen them
- Sometimes a small number of items is good
- But depends on task and available screen estate

Long-term memory (LTM)

- Repository for all our knowledge
  - slow access ~ 1/10 second
  - slow decay, if any
  - huge or unlimited capacity

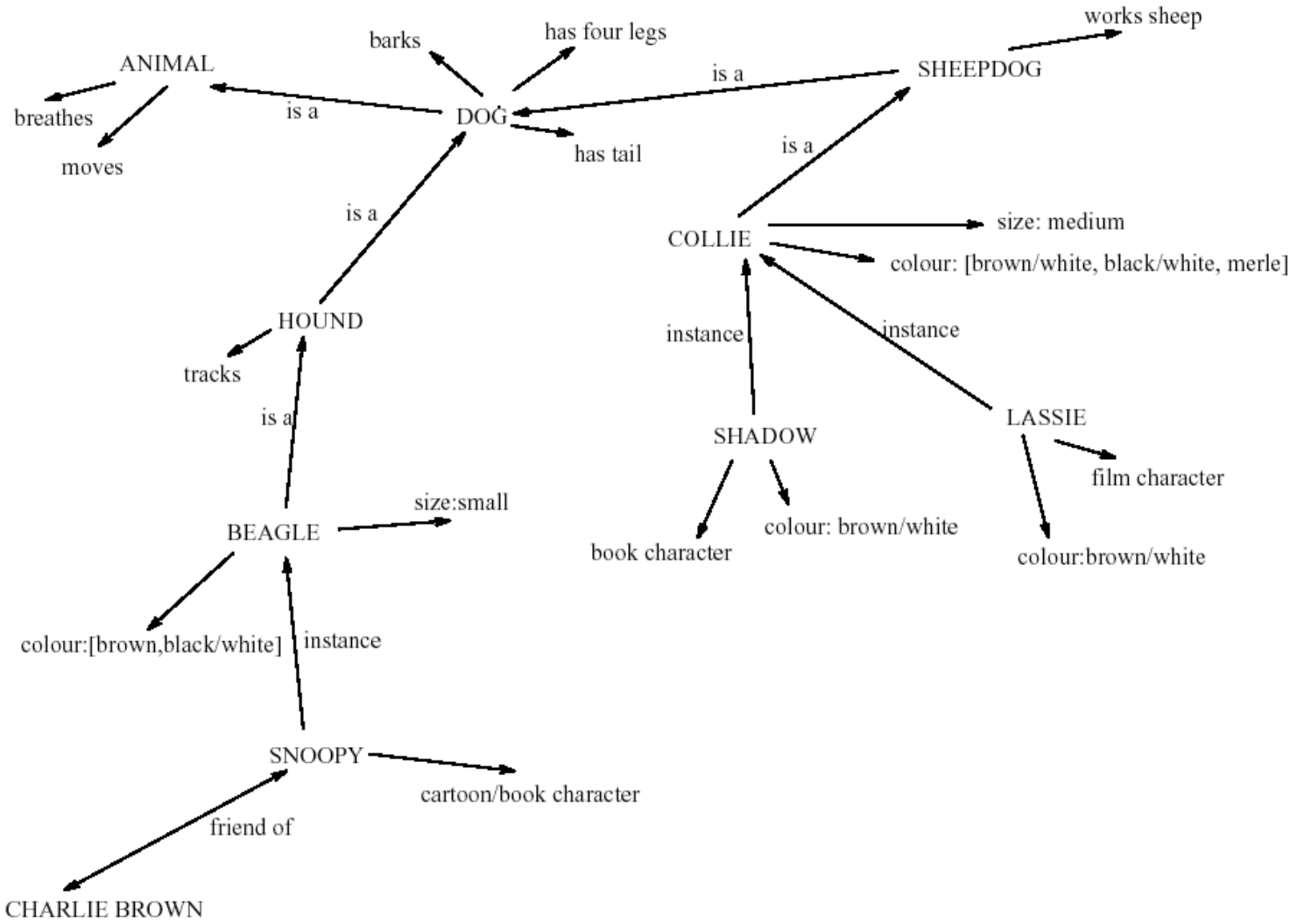
- Two types (Encoding)
  - episodic – serial memory of events
  - semantic – structured memory of facts, concepts, skills

semantic LTM is derived from episodic LTM

Long-term memory (cont.)

- Semantic memory structure
  - provides access to information
  - represents relationships between bits of information
  - supports inference
- Model: semantic network
  - inheritance – child nodes inherit properties of parent nodes
  - relationships between bits of information explicit
  - supports inference through inheritance

LTM - semantic network



LTM - retrieval

recall

- information reproduced from memory can be assisted by cues, e.g. categories, imagery

recognition

- information gives knowledge that it has been seen before
- less complex than recall - information is cue

Activity

- Try to remember the dates of your grandparents' birthday
- Try to remember the cover of the last two DVDs you bought or rented
- Which was easiest? Why?
- People are very good at remembering visual cues about things
  - e.g. the color of items, the location of objects and marks on an object
- They find it more difficult to learn and remember arbitrary material
  - e.g. birthdays and phone numbers

Recognition versus recall

- Command-based interfaces require users to recall from memory a name from a possible set of 100s
- GUIs provide visually-based options that users need only browse through until they recognize one
- Web browsers, MP3 players, etc., provide lists of visited URLs, song titles etc., that support recognition memory

Memory

- Involves first encoding and then retrieving knowledge
- We don't remember everything - involves filtering and processing what is attended to
- Design Implications:
  - Context is important in affecting our memory (i.e. where, when)
  - We recognize things much better than being able to recall things

Processing in memory

- Encoding is first stage of memory
  - determines which information is attended to in the environment and how it is interpreted
- The more attention paid to something…
- The more it is processed in terms of thinking about it and comparing it with other knowledge…
- The more likely it is to be remembered
  - e.g. when learning about HCI, it is much better to reflect upon it, carry out exercises, have discussions with others about it, and write notes than just passively read a book, listen to a lecture or watch a video about it

Context is important

- Context affects the extent to which information can be subsequently retrieved
- Sometimes it can be difficult for people to recall information that was encoded in a different context:
  - "You are on a train and someone comes up to you and says hello. You don't recognize him for a few moments but then realize it is one of your neighbours. You are only used to seeing your neighbour in the hallway of your apartment block and seeing him out of context makes him difficult to recognize initially"

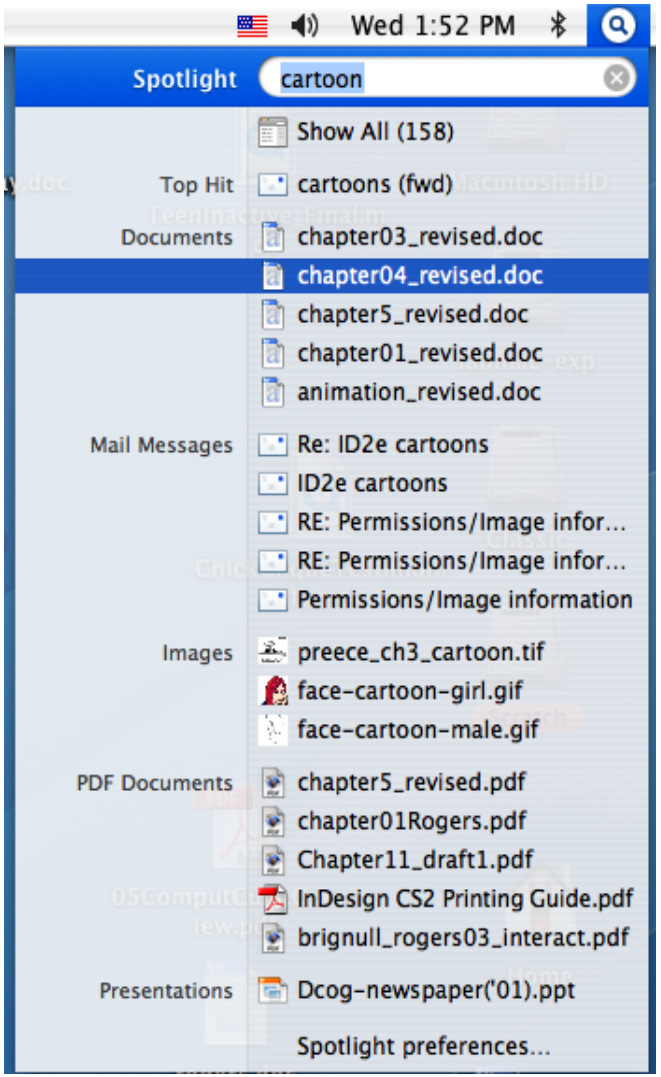
Personal information management

- Personal information management is a growing problem for many users
  - vast numbers of documents, images, music files, video clips, emails, attachments, bookmarks, etc.,
  - where and how to save them all, then remembering what they were called and where to find them again
  - naming most common means of encoding them
  - but can be difficult to remember, especially when have 1000s and 1000s
  - How might such a process be facilitated taking into account people's memory abilities?

Personal information management

- Memory involves 2 processes
  - **recall-directed** and **recognition-based scanning**
- File management systems should be designed to optimize both kinds of memory processes
  - e.g. Search box and history list
- Help users encode files in richer ways
  - Provide them with ways of saving files using colour, flagging, image, flexible text, time stamping, tags, etc

Is Apple's Spotlight search tool any good?



Memory aids

- SenseCam developed by Microsoft Research Labs
- a wearable device that intermittently takes photos without any user intervention while worn
- digital images taken are stored and revisited using special software
- Has been found to improve people's memory, suffering from Alzheimers

SenseCam

Design implications

- Don’t overload users’ memories with complicated procedures for carrying out tasks
- Design interfaces that promote recognition rather than recall
- Provide users with various ways of encoding information to help them remember
  - e.g. categories, tags, color, flagging, time stamping

Mental models

- Users develop an understanding of a system through learning about and using it
- Knowledge is sometimes described as a mental model:
  - How to use the system (what to do next)
  - What to do with unfamiliar systems or unexpected situations (how the system works)
- People make inferences using mental models of how to carry out tasks

Mental models

- Craik (1943) described mental models as:
  - internal constructions of some aspect of the external world enabling predictions to be made
- Involves unconscious and conscious processes
  - images and analogies are activated
- Deep versus shallow models
  - e.g. how to drive a car and how it works

Design implications

- Design interfaces that encourage exploration
- Design interfaces that constrain and guide learners
- Dynamically linking concepts and representations can facilitate the learning of complex material

External cognition

- Concerned with explaining how we interact with external representations (e.g. maps, notes, diagrams)
- What are the cognitive benefits and what processes involved
- How they extend our cognition
- What computer-based representations can we develop to help even more?

Externalizing to reduce memory load

- Diaries, reminders, calendars, notes, shopping lists, to-do lists
  - written to remind us of what to do
- Post-its, piles, marked emails
  - where placed indicates priority of what to do
- External representations:
  - Remind us that we need to do something (e.g. to buy something for mother's day)
  - Remind us of what to do (e.g. buy a card)
  - Remind us when to do something (e.g. send a card by a certain date)

Computational offloading

- When a tool is used in conjunction with an external representation to carry out a computation (e.g. pen and paper)
- Try doing the two sums below (a) in your head, (b) on a piece of paper and c) with a calculator.
  - 234 x 456 =??
  - CCXXXIIII x CCCCXXXXXVI = ???
- Which is easiest and why? Both are identical sums

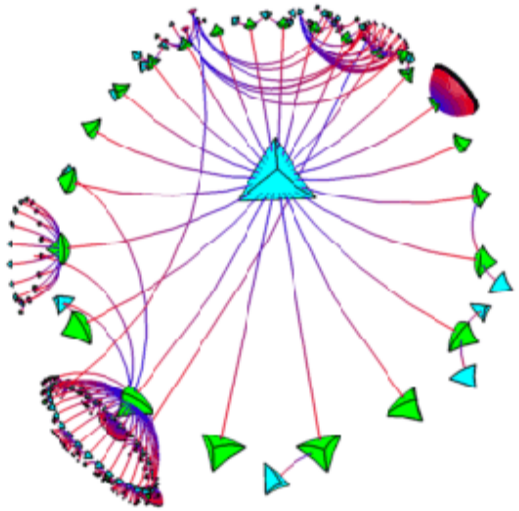
Annotation and cognitive tracing

- Annotation involves modifying existing representations through making marks
  - e.g. crossing off, ticking, underlining

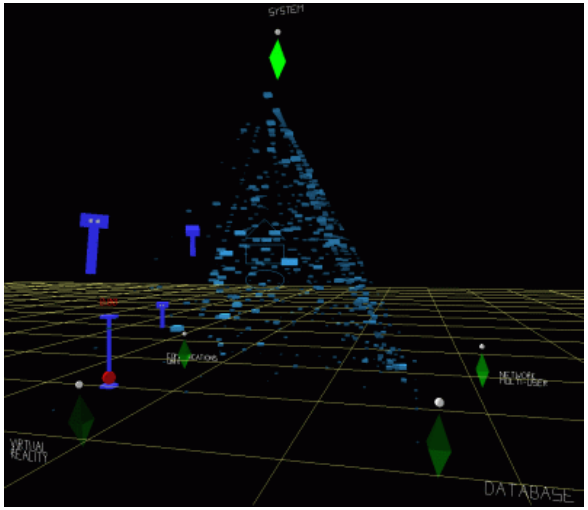
- Cognitive tracing involves externally manipulating items into different orders or structures
  - e.g. playing Scrabble, playing cards

Design implication

- Provide external representations at the interface that reduce memory load and facilitate computational offloading



e.g. Information visualizations have been designed to allow people to make sense and rapid decisions about masses of data



Summary

- Cognition involves several processes including attention, memory, perception and learning
- The way an interface is designed can greatly affect how well users can perceive, attend, learn and remember how to do their tasks
- Theoretical frameworks, such as mental models and external cognition, provide ways of understanding how and why people interact with products
- This can lead to thinking about how to design better products